GE Medical Systems

Technical Publications

Direction 2173221−100

Revision 5

AMX−4+ Ratings and Specifications (Model 2169360, 2236420 & 2275938 Series)

Operating Documentation

WARNING

- **THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.**
- **IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.**
- **DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.**
- **FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.**

AVERTISSEMENT

- **CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.**
- **SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.**
- **NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.**
- **LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.**

WARNUNG

- **DIESES KUNDENDIENST-HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.**
- **FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.**
- **VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST-HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.**
- **WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.**

AVISO

- **ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.**
- **SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.**
- **NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.**
- **LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.**

ATENÇÃO

- **ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.**
- **SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.**
- **NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.**
- **O NÃO CUMPRIMENTO DESTE AVISO PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A' CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.**

AVVERTENZA

- **IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.**
- **SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.**
- **SI PROCEDA ALLA MANUTENZIONE DELL'APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.**
- **NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL'ADDETTO ALLA MANUTENZIONE, ALL'UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.**

警告

・このサービスマニュアルには英語版しかありません。
・ＧＥＭＳ以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
・このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないで下さい。
・この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。

注意:

- 本维修手册仅存有英文本。
- 非 GEMS 公司的维修员要求非英文本的维修手册时，客户需自行负责翻译。
- 未详细阅读和完全了解本手册之前，不得进行维修。
- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

Direction 2173221−100

Revision 5

AMX−4+ Ratings and Specifications (Model 2169360, 2236420 & 2275938Series)

IMPORTANT! . . . X-RAY PROTECTION

X-ray equipment if not properly used may cause injury. Accordingly, the instructions herein contained should be thoroughly read and understood by everyone who will use the equipment before you attempt to place this equipment in operation. The General Electric Company, Medical Systems Group, will be glad to assist and cooperate in placing this equipment in use.

Although this apparatus incorporates a high degree of protection against x-radiation other than the useful beam, no practical design of equipment can provide complete protection. Nor can any practical design compel the operator to take adequate precautions to prevent the possibility of any persons carelessly exposing themselves or others to radiation.

It is important that everyone having anything to do with x-radiation be properly trained and fully acquainted with the recommendations of the National Council on Radiation Protection and Measurements as published in NCRP Reports available from NCRP Publications, 7910 Woodmont Avenue, Room 1016, Bethesda, Maryland 20814, and of the International Commission on Radiation Protection, and take adequate steps to protect against injury.

The equipment is sold with the understanding that the General Electric Company, Medical Systems Group, its agents, and representatives have no responsibility for injury or damage which may result from improper use of the equipment.

Various protective material and devices are available. It is urged that such materials or devices be used.

CAUTION: United States Federal law restricts this device to use by or on the order of a physician.

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If you have any comments, suggestions or corrections to the information in this document, please write them down, include the document title and document number, and send them to:

GENERAL ELECTRIC COMPANY
MEDICAL SYSTEMS

MANAGER – INFORMATION INTEGRATION, AMERICAS W–622
P.O. BOX 414
MILWAUKEE, WI 53201–0414

CERTIFIED ELECTRICAL CONTRACTOR STATEMENT

All electrical installations that are preliminary to positioning of the equipment at the site prepared for the equipment shall be performed by licensed electrical contractors. In addition, electrical feeds into the Power Distribution Unit shall be performed by licensed electrical contractors. Other connections between pieces of electrical equipment, calibrations, and testing shall be performed by qualified GE Medical personnel. The products involved (and the accompanying electrical installations) are highly sophisticated, and special engineering competence is required. In performing all electrical work on these products, GE will use its own specially trained field engineers. All of GE's electrical work on these products will comply with the requirements of the applicable electrical codes.

The purchaser of GE equipment shall only utilize qualified personnel (i.e., GE's field engineers, personnel of third-party service companies with equivalent training, or licensed electricians) to perform electrical servicing on the equipment.

DAMAGE IN TRANSPORTATION

All packages should be closely examined at time of delivery. If damage is apparent, have notation "**damage in shipment**" written on **all** copies of the freight or express bill **before** delivery is accepted or "signed for" by a General Electric representative or a hospital receiving agent. Whether noted or concealed, damage **MUST** be reported to the carrier **immediately** upon discovery, or in any event, within **14** days after receipt, and the contents and containers held for inspection by the carrier. A transportation company will not pay a claim for damage if an inspection is not requested within this **14** day period.

Call Traffic and Transportation, Milwaukee, WI (414) 827–3449 / 8*285–3449 **immediately** after damage is found. At this time be ready to supply name of carrier, delivery date, consignee name, freight or express bill number, item damaged and extent of damage.

Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins.

6/17/94

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REVISION HISTORY

REV	DATE	REASON FOR CHANGE
A	Oct. 30, 1996	Draft copy.
0	Dec. 13, 1996	Initial release.
1	Mar. 7, 1997	Changed Tube Column (Section 2−4) rotation to 270 degrees.
2	Aug. 14, 1997	High Impact Inspection.
3	Sept. 16, 1997	Added Keithly Non−Invasive Divider to kVp calibration and verification (Section 2−9−1).
4	Apr. 12, 1999	Added AMX−4+ Model 2236420.
5	Nov. 8, 2000	Added AMX−4+ Model 2275938.

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SECTION 1
INTRODUCTION

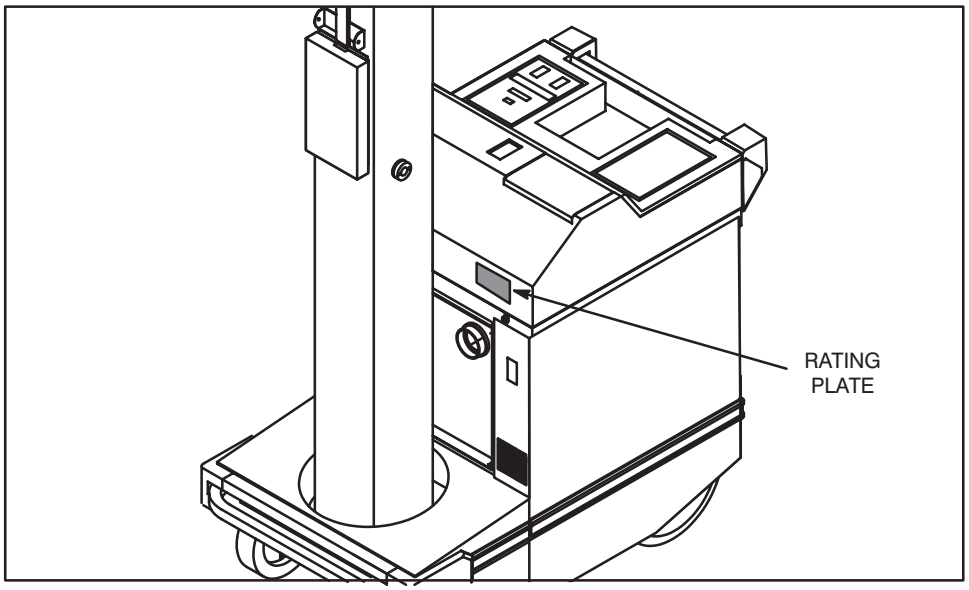
1-1 Identification and Compatibility

See Illustration 1−1. The AMX−4+ is identified by Model Number on the rating plate located on the top cover. Model part and catalog numbers are identified in Table 1−1.

TABLE 1−1
AMX−4+ MODELS

DESCRIPTION	PART NUMBER	CATALOG NUMBER	PART NUMBER	CATALOG NUMBER
DOMESTIC	2169360−7	A0659F	2236420−7 & 2275938−7	A0659JF
DOMESTIC, AEC	2169360−8	A0659FA	2236420−8 & 2275938−8	A0659JG
DOMESTIC, TECH SWITCH	2169360−9	A0659FC	2236420−9 & 2275938−9	A0659JH
DOMESTIC, AEC, TECH SWITCH	2169360−10	A0659FB	2236420−10 & 2275938−10	A0659JJ
IEC, EMC	2169360	A0659A	2236420 & 2275938	A0659J
IEC, EMC, AEC	2169360−2	A0659AA	2236420−2 & 2275938−2	A0659JA
IEC, EMC, TECH SWITCH	2169360−3	A0659AB	2236420−3 & 2275938−3	A0659JB
IEC, EMC, AEC, TECH SWITCH	2169360−4	A0659AC	2236420−4 & 2275938−4	A0659JC
JAPAN	2169360−5	A0659C	2236420−5 & 2275938−5	A0659JD
JAPAN SHORT COLUMN	2169360−6	A0659D	2236420−6 & 2275938−6	A0659JE

ILLUSTRATION 1−1
AMX−4+ IDENTIFICATION



The applicable components making up the AMX−4+ are identified with the nameplate statement, **"***this product conforms to all applicable standards under 21 CFR part 1020***,"** or **"***complies with radiation performance standards, 21 CFR sub- chapter J***."**

TABLE 1−2
AMX−4+ COMPONENTS

Component	Model No.	Nameplate Location
HV Transformer	46−270954G1	Duplicate plate on front of top cover above circuit breaker
HRT X−Ray Tube Housing	46−155750G8	Rear trim cover
Maxiray 75 TH 111 X−Ray Tube Housing	2185226	Rear trim cover
Collimator	46−270615P2	Right side of Collimator
Mobil−AID D1300 Automatic Exposure Control*	46−279732P4 (A8413BA)	Duplicate plate on front of top cover above AEC paddle
***Note:** Mobil−AID is present only on AMX−4+ Models 2169360−2, −4, −8, −10, 2236420−2, −4, −8, −10 and 2275938−2, −4, −8, −10.		

1-2 General

The AMX−4+ contains operating safeguards to provide maximum safety. Before calling for service, be certain proper operating procedures are being used. Refer to Direction 2166913−100, *AMX−4+ Operation,* or Direction 2166911−100, *AMX−4+ International Operation,* for proper operating procedures.

Satisfactory equipment performance requires the use of service personnel specially trained on x−ray apparatus. GE Medical Systems is responsible for the effects on safety, reliability, and performance only if the following conditions are met:

- The electrical wiring of the relevant rooms complies with all national and local codes.
- All assembly operations, extensions, re-adjustments, modifications, or repairs are carried out by GE Medical Systems, authorized service representatives.
- The equipment is used in accordance with the instructions for use. Refer to Direction 2166913−100, *AMX−4+ Operating Manual,* or Direction 2166911−100, *AMX−4+ International Operation,* for proper operating procedures.

CAUTION

AMX−4+ contains high voltage circuits for generating x−rays. Only trained and qualified personnel should be permitted access to the internal parts of this equipment.

1-3 Inspection

In order to assure continued performance of this x−ray equipment, a Periodic Maintenance program must be established in accordance with 2173227−100 *AMX−4+ Periodic Maintenance*. It is the owner's responsibility to supply or arrange for this service.

1-4 HHS Testing

The United States Department of Health and Human Services (HHS) has established performance requirements for diagnostic x−ray equipment. These requirements are defined in Title 21 of the Code of Federal Regulations, and apply only to certain specified components identified as “certified equipment.”

The manufacturer of specified diagnostic x−ray components must certify that the components:

1. Perform as required by the HHS standard when installed, adjusted, and tested as specified in the manufacturer’s instructions to the assembler.

   Refer to Direction 2173222−100 *AMX−4+ Installation* for HHS compliance testing as it pertains to the AMX−4+ during installation.

2. Will continue to comply when maintained in accordance with the manufacturer’s instructions.

   Refer to Direction 2173227−100 *AMX−4+ Periodic Maintenance* for periodic HHS compliance testing for the AMX−4+.

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SECTION 2
SPECIFICATIONS

2-1 Accuracy Criteria

Specified accuracies are subject to additional errors for accuracy of instrumentation used during calibration and measurement. To achieve generator accuracies, the following criteria must be met:

- The **WAIT** message must not appear on the Message Display when taking an exposure.
- The **READY FOR EXPOSURE** message must appear on the Message Display.

General Electric Medical Systems reserves the right to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

2-2 Physical Characteristics

2-2-1 Dimensions (All measures are nominal)

1. Height: 70 inches (1778 mm) for Models 2169360−6 and 2236420−6 & 2275938−6; all others 76 inches (1930 mm).
2. Width: 25−3/16 inches (640 mm)
3. Length: 45−3/8 inches (1153 mm)
4. Weight: 1080 pounds (490 kg)

2-2-2 Environmental Limits

1. Operating temperature range: 59 to 100 Degrees Fahrenheit (15 to 38 Degrees Celsius) at 80% non−condensing humidity.
2. Storage temperature range −40 to +140 Degrees Fahrenheit (−40 to +60 Degrees Celsius)
3. Maximum operating altitude: 8,000 feet (2440 meters).

2-3 Battery

1. Nine 12.9 volt batteries connected in series provide approximately 116 volts at full charge.
2. Battery charger requires the following:
   - For Models 2169360−7, 2169360−8, 2169360−9, 2169360−10, 2236420−7 & 2275938−7, 2236420−8 & 2275938−8, 2236420−9 & 2275938−9, 2236420−10 & 2275938−10: 120 Volts AC, 60 Hz at 6 A.
   - For Models 2169360, 2169360−2, 2169360−3, 2169360−4, 2236420 & 2275938, 2236420−2 & 2275938−2, 2236420−3 & 2275938−3, 2236420−4 & 2275938−4: 220/240 Volts AC, 50 Hz at 3.15 A.
   - For Models 2169360−5, 2169360−6, 2236420−5 & 2275938−5, 2236420−6 & 2275938−6: 100 Volts AC, 50/60 Hz at 6 A.

Voltage must be maintained to ±10% of the nominal value during charging.

2-3-1 Battery Capacity

The AMX−4+ battery capacity can be measured by one of the following five methods. All capacities are measured after the AMX−4+ has been charged to the "CHARGE COMPLETE" state. Available capacity as stated applies only to new battery sets free of defective cells. Capacity may decrease as the battery nears the end of its useful life.

METHOD 1: EXAMS

The AMX−4+ batteries will provide capacity for more than 20 typical EXAMs. An "EXAM" is defined as:

- Two 70 kVp, 10 mAs x−ray exposures including:
  - 7 seconds of prep (rotor and filament drive)
  - 25 seconds of field light
- 5 minutes of drive time
- 9 minutes of idle time

The formula in the "VARIED USAGE" section can be used to determine the number of total EXAMs available for usage regimes different from this typical case.

METHOD 2: X−RAY EXPOSURES

The AMX−4+ batteries will provide enough capacity for 165 or more 100 kVp, 100 mAs x−ray exposures. Each exposure includes 4 seconds of prep (rotor and filament drive) time and 30 seconds of idle time for battery recovery. This number may be reduced by additional idle time required for x−ray tube cooling.

METHOD 3: DRIVE TIME

The AMX−4+ batteries will provide enough capacity for 140 minutes of continuous drive time. This time is typically independent of driving conditions, however, it may be reduced if a significant portion of the drive is on carpeting or up ramps.

METHOD 4: IDLE TIME

The AMX−4+ batteries will provide capacity for 23.3 hours of continuous idle time. "Idle" is the time when the AMX−4+ is ON but not being used.

METHOD 5: VARIED USAGE

For varied usage, the AMX−4+ batteries will provide capacity according to the following formula:

{ (idle time *in minutes*) × 3} +
{ (drive time *in minutes*) × 30} +
{ (field light time *in minutes*) × 25 } +
{ (prep time *in minutes*) × 30} +
{ (exposure energy*) × 2.17} = 4200

*exposure energy = cumulative { (kVp × mAs) ÷ 1000 }

EXAMPLE: Assume one desires to estimate the number exams available from an AMX−4+ used in a particular pediatric ward. It is determined that a typical exam for this case is comprised of:

- Two 70 kVp, 0.8 mAs x−ray exposures including:
  - 3 seconds of prep
  - 15 seconds of field light
- 1 minute of drive
- 5 minutes of idle

Using the above formula we can estimate the number of exams as follows:

each EXAM uses
{ (5 idle *minutes*) × 3} +
{ (1 drive *minutes*) × 30} +
2 x [{ (15 ÷ 60 field light *minutes*) × 25} +
{ (3 ÷ 60 prep *minutes*) × 30} +
{ ((70 kVp × 0.8 mAs) ÷ 1000) × 2.17}] = 60.7

therefore the total number of typical EXAMs available is:
4200 ÷ 60.7 ≈ 69

2-4 Movements

1. Tube vertical movement measured at the focal spot (arm extended):
   a. Range — at least 46.5 inches (1181 mm) for Models 2169360−6 and 2236420−6 & 2275938−6, all others at least 52.5 inches (1334 mm).
   b. Lowest position — 26.1 inches (663 mm) max. from floor.
   c. Highest position — 72.6 inches (1844 mm) min. from floor for Models 2169360−6 and 2236420−6 & 2275938−6; all others 78.6 inches (1996 mm) min. from floor.
2. The horizontal movement measured at the focal spot relative to column face is 24 inches (610 mm) minimum, to 40 inches (1016 mm) maximum.
3. Tube Column rotation measured from horizontal arm latch is ±270 degrees.

4. Tube and yoke rotation around Horizontal Arm measured from tube port down position:

   a. Range 360 degrees;

   b. Detent locations 0, ±90, and ±180 degrees.

5. Tube Trunnion rotation measured from tube port down position:

   a. Range 120 degrees;

   b. Forward 110 degrees;

   c. Backward 10 degrees;

   d. Detent 0 degrees, and 90 degrees.

6. Collimator Rotation measured from the front of the collimator with the tube port facing down:

   a. Range 180 degrees;

   b. Right 90 degrees;

   c. Left 90 degrees;

   d. Detent 0 and 90 degrees.

2-5 Moving Efforts

1. Moving efforts with locks mechanically off (that is, energized electrically):

   a. Vertical tube motion: 12 pounds (53 Newtons) maximum, measured going up or down; 15 pounds (67 Newtons), measured over last 4 inches (102 mm) of travel.

   b. Horizontal tube motion: 14 pounds (62.3 Newtons) maximum, measured going in or out.

   c. Tube Column rotation: 15 pound−feet (20.3 Newton−meters) maximum.

   d. Tube and yoke angulation around horizontal Arm: 10 to 20 pound−feet (14 to 27 Newton−meters) to disengage from detent, 6 to 18 pound−feet (8 to 24 Newton−meters) to rotate between detents.

   e. Tube rotation in yoke: 7 to 18 pound−feet (9.5 to 24 Newton−meters) to disengage from detent, 4 to 13 pound−feet (5 to 18 Newton−meters) to rotate between detents.

2. Moving efforts with locks mechanically on (that is, not energized electrically):

   a. Vertical tube motion: 15 pounds (67 Newtons) minimum, 32 pounds (142 Newtons) maximum; measured going up or down.

   b. Horizontal tube motion: 10 pounds (44.5 Newtons) minimum, 28 pounds (125 Newtons) maximum; measured going in or out.

   c. Tube Column rotation: 25 to 40 pound−feet (34 to 54 Newton−meters).

2-6 Drive Speed

There are two speeds: Drive Speed with the horizontal Tube Arm secured for transport, and Maneuvering Speed with the horizontal Tube Arm removed from the Transport Latch.

Drive speed is measured on a smooth, hard and level surface. Speed will be reduced by inclines, carpeted or soft surfaces.

1. Drive Speed is 264 feet (6705 mm) per minute ± 25%;
2. Maneuvering Speed is 30% to 60% of drive speed.

2-7 Tube Unit Ratings

Tube Housing and Insert Specifications are given in Direction 46−017226, *Tube Ratings, HRT 50 and 60 Hz.*, *or in 2236721−100, Product Data Sheet Maxiray 75 TH 11 X−ray Tube*. Also, refer to note on maximum allowable kVp and mAs ratings in 2166913−100 *AMX−4+ Operating Manual*.

2-8 Generator Operator Indicators

Check for proper operation of tones or buzzers and labels as required by regulations. Reference "Generator Operator Indicators" in Tab 3 of Direction 46−013894, *System Field Test for HHS.*

1. X−ray on indicator lights during an exposure.
2. Audible tone occurs during exposure.
3. Audible tone occurs with safety timed termination of AEC exposures.
4. Safety timed termination of AEC exposures requires resetting before taking another exposure.
5. X−ray warning label is legible.

2-9 kVp Accuracy

1. Rise time of the kVp wave form from 10% to 90% of the maximum kVp is 1.2 millisecond or less.
2. Fall time of the kVp wave form from 90% of the maximum kV to 20 kV is 2.5 milliseconds or less.
3. Accuracy of the kVp wave form to selected kVp is ± 8% of the value displayed on the operator panel for the first 20 ms and ± 5% after 20 ms. Accuracy applies within the range of the bar graph battery charge indicator.

Note: These specifications do not apply to switching transients which occur during the first millisecond and the last millisecond of an exposure.

2-9-1 Test Method

Preferred

Use a Keithley Non−Invasive kVp Divider (Model 35080A with Deviation 535 or Model 35080B, both using Mobile Filter Pack Plus 37946C and optional Low Range Filter Pack 38237C). A Triad 35050A Dosimeter can also be used to provide digital readout of corrected kVp values. **No other substitutions for non−invasive kVp Dividers are approved!**

The set−up procedure and linear correction curves (non−Triad systems) for using the Keithley divider are covered in Section 3 of Direction 46−017561 *HHS Control and Tube Assembly Tests* and Keithley's Operation and Maintenance manuals.

Alternate

Use the GE C1515A Invasive Bleeder. If this method is used, the unit should be calibrated and verified with this meter.

Note: If an attempt is made to verify a unit calibrated with a C1515A bleeder with either of the above Keithley Non−Invasive dividers, kVp readings will read 5−7 kVp higher than when read with the C1515A. This is due to impedance changes in the high voltage circuit with the bleeder removed from the circuit and due to frequency compensation errors present using the C1515A divider with the AMX−4+ waveform.

The procedure for connecting the C1515A High Voltage divider is covered in Direction 46−013288 *Bleeder, High−Voltage Dual Type T8005G and C1515A Connection ... Applications,* and Direction 2196272−100, *High Voltage Cable Installation and Troubleshooting Procedures*.

Make exposures and calculations as described in "Technique Accuracy − kV/mA" in Tab 3 of Direction 46−013894 *System Field Test for HHS.*

2-10 mAs Metering Accuracy

Accuracy of mAs is the integral of x−ray tube emission current between the time at which the kV wave form reaches 75% of the indicated peak value at the beginning of an exposure and the time at which it falls to 75% of the indicated peak value when the exposure is terminated.

Actual mAs shall match selected mAs within ±10%.

2-10-1 Test Method

This is an indirect procedure which verifies accuracy of the mAs metering circuitry and mAs calibration. Measuring mAs Metering Accuracy is done by injecting 100 mA into the mAs integrating circuit and comparing the response with a meter installed in the circuit. Reference Direction 2173223−100, *AMX−4+ Calibration* − familiarity with this direction is assumed. Also reference "Technique Accuracy − mAs" in Tab 3 of Direction 46−013894, *System Field Test for HHS.*

1. Enter mAs calibration and install meter.
2. At the prompt **ENTER VALUE** compare meter reading with displayed reading.

3. Correct reading to include meter accuracy before comparing with requirements.

Note: Accuracy of mA reading at the approximate 100 mA test condition is ± 0.1 mA. Meter accuracy must be added to the mA reading before making judgment on the final reading.

2-11 Reproducibility

The coefficient of variation for radiation output is less than 0.045 for successive exposures having constant technique factors.

Coefficient of variation is measured and calculated as described in "Reproducibility of Exposure" in Tab 3 of Direction 46−013894, *System Field Test for HHS.* This applies to all units for non−AEC mode − reference the procedure "for exposures made without the use of A.E.C." For units equipped with Mobil−AID, also reference the procedure "for exposures made with an A.E.C."

2-12 Beam Quality

The half−value layer of the useful beam at 80 kVp shall not be less than 2.5 millimeters of aluminum. This requirement differs slightly from and supersedes NCRP 33. The specific test point is at 80 kVp requiring a half value layer of 2.5 millimeters of aluminum.

2-12-1 Test Method

The procedure for measuring Beam Quality is presented in "Beam Quality (Half Value Layer)" in Tab 4 of Direction 46−013894 *System Field Test for HHS*. The following noted exceptions to that procedure apply for the AMX−4+:

1. Select initial technique factors of 80 kVp and 20 to 48 mAs.
2. When making an exposure without the absorber, adjust mAs so that the radiation meter reading contains three significant digits.
3. Use an AMX−4 absorber 46−173632G2 in the collimator rails.

2-13 Collimator Function

Manual collimator Model 46−270615P2 bearing an HHS certification label is installed on the AMX−4+. Reference "Functional Test − Manual Rad Collimator Version" in Tab 6 of Direction 46−013894, *System Field Test for HHS*.

1. Minimum source to skin distance is limited to more than 30 centimeters by the skin spacers at the beam exit of the collimator.
2. Full 17 by 17 inch (43 by 43 centimeters) radiographic coverage at 40 inch (1.02 meter) Source to Image Distance.
3. Minimum inherent filtration of 2.0 mm aluminum equivalent at 100 kVp.

2-14 Collimator Alignment and SID

Collimator Alignment and SID tests are performed in accordance with Tab 6 of Direction 46−013894, *System Field Test for HHS,* reference:

SID Test
Light to X−ray Field Test
Center to Center Test
Field Indicator (Pointers to Actual Size)

1. The x−ray field size must agree with the indicated field size within 1.8% of SID.
2. Total misalignment of parallel edges of the light field with the edges of its x−ray field must not exceed 1.7% of SID.
3. The difference between the indicated SID and the actual SID must not exceed 1.8% of the indicated SID.

2-15 Collimator Light Field Intensity

The average illumination at a distance of 100 cm (39.37 inch) from the focal spot shall be 16 foot candles (170 lux) or more. Reference “Collimator Light Field Intensity” in Tab 6 of Direction 46−013894, *System Field Test for HHS.*

2-16 AEC Minimum Exposure Time

(Applies to units equipped with Mobil−AID)

When the x−ray kVp is equal to or greater than 50 kVp, the minimum exposure time will be equal to or greater than the time interval required to deliver 5 mAs. Reference “AEC Minimum Exposure Time” in Tab 3 of Direction 46−013894, *System Field Test for HHS.*

SECTION 3
HHS TEST CHECKLISTS

The importance of HHS compliance testing cannot be over emphasized. Before starting these procedures, review Direction 46−013894 *System Field Test for HHS.* Pay particular attention to "Introduction" (Tab 1 of Direction 46−013894).

With the exception of Collimator Function and Beam Quality, all field tests for HHS compliance are to be performed at specified intervals.

3-1 HHS Tests (Excluding AEC)

Requirements are pass or fail. Service is required if any Requirement is failed. After each Requirement is verified, place a check in its box. Record notes and comments next to the Requirement.

Inspect	Requirement	Inspector's Notes
3-1-1 Generator Operator Indicators Required during Installation, preventative maintenance calls, or when replacing major components.	☐ Check for proper operation of tones and buzzers as required by regulations. Refer to "Generator Operator Indicators" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings And Specifications*, and perform defined inspection.	
3-1-2 Technique Accuracy − kVp / mA Required during Installation, preventative maintenance calls, and repair.	☐ Actual kVp matches select kVp. Refer to "kV Accuracy" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform procedure.	
3-1-3 Indirect Linearity Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "Indirect Linearity" in Tab 3 of Direction 46−013894, *System Field Test for HHS.*	
3-1-4 Technique Accuracy − mAs Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "mAs Metering Accuracy" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedure.	
3-1-5 Reproducibility Of Exposures − Non−AEC Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "Reproducibility" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedure for non−AEC mode exposures.	

Inspect	Requirement	Inspector's Notes
3-1-6 Beam Quality (Half Value Layer) Required during Installation, or after replacement of tube unit, collimator, or other absorption between source and patient.	☐ Refer to "Beam Quality" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedure.	
3-1-7 Collimator Function Required during Installation, or after replacement of collimator.	☐ Refer to "Collimator Function" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined checks.	
3-1-8 Collimator Alignment and SID Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "Collimator Alignment and SID" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedures.	
3-1-9 Collimator Light Field Intensity Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "Collimator Light Field Intensity" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedure.	

3-2 AEC HHS Tests
(Units with Mobil−AID)

Requirements are pass or fail. Service is required if any Requirement is failed. After each Requirement is verified, place a check in its box. Record notes and comments next to the Requirement.

Inspect	Requirement	Inspector's Notes
3-2-1 Reproducibility Of Exposures − AEC Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "Reproducibility" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedure for AEC mode exposures.	
3-2-2 AEC Minimum Exposure Time Required during Installation, preventative maintenance calls, and repair.	☐ Refer to "AEC Minimum Exposure Time" in Section 2 of Direction 2173221−100, *AMX−4+ Ratings & Specifications*, and perform defined procedure.	

GE Medical Systems

GE Medical Systems: Telex 3797371
P.O. Box 414, Milwaukee, Wisconsin 53201 U.S.A.
(Asia, Pacific, Latin America, North America)

GE Medical Systems — Europe: Telex 698626
283, rue de la Miniére, B.P. 34, 78533 Buc Cedex
France